Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	
Federal-State Joint Board on Universal Service	CC Docket No. 96-45
Forward-Looking Mechanism for High Cost Support for Non-Rural LECS	CC Docket No. 97-160

COMMENTS OF BELL ATLANTIC[1] ON HYBRID COST PROXY MODEL

In these comments, Bell Atlantic provides its preliminary observations about the Commission staff's Hybrid Cost Proxy Model ("HCPM").[2] The HCPM can only be considered a work in progress at this point, as the staff has only released two modules (the customer location and loop design modules), with partial input data only for the state of Colorado and four additional wire centers. Also, the study documentation includes numerous references to modifications that will be included in future releases. Given

[1] The Bell Atlantic telephone companies ("Bell Atlantic") are Bell Atlantic-Delaware, Inc.; Bell Atlantic-Maryland, Inc.; Bell Atlantic-New Jersey, Inc.; Bell Atlantic-Pennsylvania, Inc.; Bell Atlantic-Virginia, Inc.; Bell Atlantic-Washington, D.C., Inc.; Bell Atlantic-West Virginia, Inc.; New York Telephone Company; and New England Telephone and Telegraph Company.

[2] Bell Atlantic also submits the attached affidavit prepared by Harold Ware of National Economic Research Associates, which evaluates the HCPM and compares it to the results of the Hatfield model and the Benchmark Cost Proxy Model ("BCPM").

these limitations, it would be premature to evaluate the staff approach against the ten criteria that the Commission has established for a cost proxy model[3] or to decide whether the model produces valid results for determining the amount of universal service support that is needed in each area. The Commission should provide an opportunity for evaluation of subsequent releases together with sufficient input data to examine model outputs for all areas. Until this is done, the Commission will not have given the parties an adequate opportunity to comment on the model. With these caveats, Bell Atlantic submits the following comments.

I. While It Still Has Not Been Shown That A Proxy Model Can Produce Valid Results For Determining Universal Service Support, The HCPM Includes Some Improvements Over The Existing Models.

Bell Atlantic continues to oppose the use of proxy models to determine universal service support levels. The proxy models that have been developed to date have several fatal defects in estimating the forward-looking cost of providing universal service. They all assume that a brand new network is built from scratch and perfectly sized to meet the current level of demand, which does not reflect the manner in which costs are incurred on a going-forward basis. They do not, and probably cannot, take into account all of the factors that determine the design, construction, and cost of an actual network. And they have not been shown to be accurate in such basic data as the number of lines and the

[3] ***See*** Federal-State Joint Board on Universal Service, 12 FCC Rcd 8776, para. 250 (1997).

locations of customers. If the Commission continues to believe that it should base universal service support on the difference between forward-looking costs and a revenue benchmark, it should use carrier-specific studies of actual forward-looking costs for that purpose.

Nonetheless, as far as proxy models are concerned, the HCPM incorporates certain improvements over the existing models.[4] The HCPM uses optimization routines to minimize the cost of building outside plant. It designs distribution areas around the maximum number of households that can be served by a service area interface, rather than creating predefined service areas, as do some of the other model releases. This could allow the HCPM to more closely approach the way that engineers actually design outside plant to serve customers. This may produce a better estimate of a least-cost network than a model that simply reflects the model designers' views of the most efficient network design.

The HCPM's use of the Turbo-Pascal programming language has advantages and disadvantages over the existing spreadsheet-based models. While it makes the model less accessible to those who are not familiar with this language, it facilitates cost minimization algorithms, and it makes those algorithms more explicit than formulae that are spread across several spreadsheets. In theory, use of this language should make the computations more efficient.

[4] ***See*** Attachment 1, pp. 5-6.

II. The HCPM Continues To Suffer From The Limitations Of A Proxy Model Approach.

The HCPM has several limitations that prevent it from adequately reflecting actual forward-looking costs.

1. Like the other models, the HCPM does not take into account all of the terrain factors that affect the design and cost of outside plant. The HCPM uses simple algorithms based on density and distance, laying out feeder in 90 degree angles. The mix of aerial, buried, and underground structure is based only on density and soil type. The Commission has criticized the Hatfield and BCPM models, which also use a density algorithm, for not taking terrain factors into account.[5] Even if the model took terrain into account, it would not include other factors, such as buildings, obstacles, availability of access to rights of way, and political or aesthetic constraints that affect the design and cost of outside plant.

2. The model locates all of the population of a census block in the grid containing the interior point of the census block. Because census blocks cross grid boundaries, this will cause customers to be assigned to the wrong wire center, and it will portray customers as more clustered in a particular grid than they really are. The HCPM's assumption that customers are uniformly distributed throughout a microgrid is also questionable. In reality, portions of many microgrids are unpopulated due to the

---

[5] ***See*** Further Notice of Proposed Rulemaking, CC Docket Nos. 96-45 & 97-160 (rel. July 18, 1997) para. 56.

existence of parks, rock formations, etc. The uniform customer distribution would tend to overstate costs in areas of low population density.

3. The HCPM does not place an upper constraint on loop costs to reflect the fact that wireless technologies would be more cost effective for customer locations beyond a certain distance from the wire center. This appears to account for the fact that the HCPM results in much higher costs than the BCPM in low density areas.[6]

4. The model infers residence lines from population data without taking into account demographic data, such as income, that influence the number of lines per household.

5. The model oversimplifies costs in high density areas by not taking into account the existence of multifamily and high rise dwellings. The model assumes that drop wire runs to a residence that is located either at the center of a lot or at the midpoint of the lot frontage. These assumptions do not take into account the wide variations in building sitings or other factors that affect drop lengths.

III. The HCPM Produces Inconsistent Results By Wire Center And Tends To Overstate Costs In Low-Density Areas.

Because of the limited nature of the HCPM modules and the incomplete input data that were made available, Bell Atlantic has not been able to perform a full analysis of the model. However, the results of Bell Atlantic's analysis of the HCPM so far show

---

[6] *See* Attachment 1, p. 14.

that the model produces unexplainable variations from actual data, and from the results of the other models.

As is discussed in Attachment 1, there are unexplained variations between the HCPM and the other models in the number of lines for each wire center, and none of the models does a good job of matching actual wire center line counts.[7] Attachment 2 compares actual line counts for selected wire centers in Colorado to the results of the HCPM, two versions of the BCPM, and the Hatfield Model.[8] The variations between the HCPM line counts and actual line counts range from minus 50 percent to plus 50 percent. For example, the HCPM calculates 2,753 lines for wire center FRSCCOMA, the latest BCPM calculates 1,235 lines, and the Hatfield model calculates 42 lines, while the actual line count is 4,344. While relatively small "closure" factors could be used at the statewide level to adjust the model wire center counts to actual lines, the closure factors at the wire center level would be so large that the model line counts cannot be considered reliable.[9]

---

[7] The variations in line counts among the models are even more extreme when residence and business lines are considered separately. ***See*** Attachment 1, p. 12. This shows that the methods of estimating business lines in the HCPM and in the other proxy models are seriously flawed.

[8] ***See*** Attachment 2, Chart 1.

[9] Moreover, the use of closure factors at the statewide level would not cure the underlying problem that inaccurate line counts at the wire center level cause the models to develop incorrect outside plant investments for each wire center. ***See*** Attachment 1, pp. 10-12.

There are similar inconsistencies among the models in the amount of investment per line by wire center. Although data for actual investment per line are not available, Attachment 2 compares the investments per line for the different models for selected wire centers in Colorado.[10] This comparison also shows variations of plus or minus 50 percent. For example, the HCPM produces an investment per line for wire center FRSCCOMA of $541, while the uncapped BCPM and Hatfield models produce investments of $1,167 and $1,867, respectively.

As is shown in Attachment 1, the HCPM generally project lower costs than the BCPM model in high density/low cost areas, and it projects higher costs in low density/high cost areas than both the Hatfield and BCPM models.[11] The HCPM's tendency to estimate higher costs than the BCPM for low density areas may be due primarily to the absence of an upper limit on loop costs, because the model does not assume that wireless loops would be the least-cost technology above a certain cost. Attachment 1 also demonstrates that there are large, and unexplainable, variations between the HCPM and the other models in the costs for individual wire centers.[12] Given these differences, and given the inaccurate line counts produced by all of the models, none of the models can be considered reliable at this time.

---

[10] ***See*** Attachment 2, Chart 2.

[11] ***See*** Attachment 1, pp. 13-14.

[12] ***See** id.*, pp. 14-16.

IV. Conclusion

While the HCPM incorporates some improvements over the other proxy models, there clearly is a need for further development. The limited analysis that has been possible at this stage raises serious questions about how the model operates and whether it can do an acceptable job of estimating costs at the wire center level. The Commission should not adopt this model without giving the parties an opportunity to comment on a complete version with all of the necessary inputs.

Respectfully submitted,

By: Joseph Di Bella

Joseph Di Bella
1320 North Court House Road
Eighth Floor
Arlington, VA 22201
(703) 974-6350

Attorneys for the Bell Atlantic Telephone Companies

Of Counsel
Edward D. Young, III
Michael E. Glover
Betsy L. Roe

Dated: November 26, 1997

ATTACHMENT 1

ANALYSIS OF HYBRID COST PROXY MODEL

HAROLD WARE, PH.D.

NATIONAL ECONOMIC RESEARCH ASSOCIATES, INC.

NOVEMBER 25, 1997

I. INTRODUCTION 1

II. SUMMARY 2
A. Analysis of the HCPM approach 2
B. Overview of comparisons with actual US West data and estimates from other proxy models 3

III. CONTRIBUTIONS OF THE HCPM 5

IV. LIMITATIONS OF THE HCPM 6
A. The HCPM, like other proxy models, oversimplifies the cost minimization problem faced by the ILECs 6
B. Like the other proxy models, the HCPM does not minimize costs subject to the same real world constraints faced by either ILECs or CLECs. 7
C. The detailed algorithms are still overly simple. 8
D. The HCPM ignores wireless technologies that could reduce costs for low-density areas. 9
E. The HCPM cannot yet be adequately tested. 9

V. COMPARATIVE ANALYSIS OF HCPM RESULTS 10
A. Wire center line-count comparisons show that the proxy models do not accurately estimate the number of lines served. 10
B. The HCPM may understate forward looking costs in more urban (high-density) areas and overstate costs for low-density areas 13
C. Analysis of individual wire center results and of specific investment components shows even more discrepancies among the models. 14
1. Wire-center results show large variations. 14
2. Variation in loop components. 15

I. INTRODUCTION

My name is Harold Ware. I am a Vice President at National Economic Research Associates (NERA). Since joining NERA, I have advised clients, directed studies and prepared testimony for regulatory proceedings and antitrust cases in a variety of industries. My research has focused on telecommunications, including: studies of costs, pricing and entry policy and universal service issues associated with the transition to competition; studies of competition in the local, interexchange, Centrex/PBX and private line markets; analyses of regulatory policy on stranded plant; analyses of competitive effects of mergers in wireless telecommunications and between telephone and cable TV companies and analyses of the planning and deployment of new technology in telecommunications networks. I have also studied competition and demand for postal services and the impact of postal rate changes. I have testified before state regulatory commissions and the U.S. Postal Rate Commission, and filed affidavit testimony before the FCC and the Department of Justice. I received a B.A. *cum laude* in Economics from the State University of New York at Stony Brook, and M.A. and Ph.D. degrees in Economics from Cornell University. While pursuing my graduate studies at Cornell, I taught courses in economics and industrial organization and did research on cellular mobile communications in the Technology Assessment Project of the Program on Science, Technology and Society. My articles have been published in *Public Utilities Fortnightly*, *IEEE Communications*, proceedings of the *Fifth* and *Seventeenth Annual Telecommunication Policy Research Conferences*, and in *Managing Change in the Postal and Delivery Industries*. I am also co-author of three chapters of *Communications for a Mobile Society: An Assessment of New Technology*.

Bell Atlantic asked me to review the FCC Staff's Hybrid Cost Proxy Model (HCPM) documentation and program, and to provide a preliminary assessment of its suitability for estimating universal service costs. This report presents the results of my analysis. It is organized as follows: Section II outlines the basic issues and summarizes my comparison of the HCPM estimates with USWest data and estimates from the other proxy models; Section III describes the contributions of the HCPM; Section IV addresses its limitations; and Section V contains a more detailed comparison of the HCPM wire center results with those of other proxy models and with USWest's actual wire center line counts.

II. SUMMARY

A. Analysis of the HCPM approach

My assessment indicates that the HCPM makes some improvements over the Hatfield Model ("HM," version 4.0) and over the Benchmark Cost Proxy Model ("BCPM," version 2.5) as a proxy cost model. However, (aside from being subject to the fundamental limitations of proxy models noted below) the HCPM's contributions do not overcome a number of important problems with the proxy models being assessed by the Commission.

- Most important, the HCPM (like the HM and BCPM) does not adequately account for real world planning problems and constraints. Thus, although the HCPM seeks to find the least cost investment mix for an area, it does not take account of many significant planning and cost constraints, and it does not do the type of cost minimization that ILECs, or any real firm would do.
    - The HCPM attempts to minimize <u>investment</u> costs; thus, it does not correctly solve the cost optimization problem. Actual firms seeking to minimize costs must make tradeoffs between initial investment costs and expenses over time. Such firms would seek the mix of plant that minimizes total lifetime costs—the net present value of initial investment cost, growth costs and maintenance costs to provide service over time. Neither the HCPM nor the other models solves this problem.
    - Furthermore, unless the HCPM is modified to incorporate expenses and growth into its cost minimization algorithms, simply adding the HCPM's investment minimization aspects into the other models would not allow them to solve the correct optimization problem either. The other models treat initial investments as inputs from which to calculate expenses. They do not seek to minimize the lifetime (investment, growth and maintenance) costs.
    - The HCPM, like the other models, assumes all demand is satisfied at one time. Growth and uncertainty are not accounted for and, thus, costs are understated. Failing to

account for growth implies that the model will use larger, more homogeneous investment increments with smaller unit costs than can be achieved in the real world.[1]

- The model is still under construction and must be refined before it can be tested adequately. For example, the creators of the model state that: "In the future versions of the model, the crossover points will be computed as a function of other input prices for cable and electronics, although the possibility of user override will remain..."[2] Thus, comments on the model must be considered to be preliminary.

In addition to the above flaws in how the proxy models are currently structured, the HCPM continues to be subject to the fundamental limitations of the task to which the FCC seeks to put proxy cost models. For example, since these models are supposed to estimate the costs for a mythical single "efficient firm" serving the entire market, they can not produce costs that would apply to either an incumbent local exchange carrier (ILEC) or a competitive local exchange carrier (CLEC).

Furthermore, it may not be possible to develop a model that adequately takes into account all of the complex tradeoffs and experience that real firms use to deploy the most efficient plant possible. Thus, relying on area-specific information and the experience of engineers with detailed knowledge of those areas may be preferable to using proxy models – even those with optimization algorithms – for application to all areas.

B. Overview of comparisons with actual US West data and estimates from other proxy models

Although the HCPM remains preliminary, and the other models remain in flux, it is useful to compare the model's results to USWest data and to estimates from the other proxy models. These preliminary comparisons show that proxy models, despite substantial efforts and expenses by their supporters, continue to have significant limitations. More specifically:

---

[1] The proponents of the proxy models may argue that growth and uncertainty are covered by the use of fill factors. The Commission should make sure that these parties can back up their arguments with sufficient evidence based on actual experience. Their use of hypothetical fill factors, often substantially above those achieved in actual networks, is unlikely to adequately capture the effects of building networks over long periods to meet demand growth and customer migration.

[2] "The Hybrid Cost Proxy Model: Customer Location and Loop Design Modules," C.A. Bush, D.M. Kennet, J. Prisbrey and W.W. Sharkey, October 30, 1997, p. 7; cited in the text that follows as "HCPM Documentation."

- The proxy model line counts differ substantially from each other and from USWest's actual wire center line counts. Although the models use elaborate databases and algorithms to estimate the number of lines in specific geographic areas, the data show that their methods remain imprecise, even at the wire center level. Since the number of lines obviously has a large impact on cost per line, the cost estimates are also inaccurate.
- Results for smaller areas such as Census Block Groups (CBGs) and Census Blocks (CBs) would be even less precise. (At the wire center level, overestimates in one CB offset underestimates in another, but this would be less likely for individual CBGs or CBs.) Further, even at the wire center level, the results will be inaccurate because the number and mix of lines assigned to areas within a wire center affects the overall costs. For example, if the model places too many lines in CBs close to the switch location, it could understate costs.
- Results with this preliminary version of the HCPM are consistent with previous evidence that the HM tends to underestimate costs. The HCPM estimates of investment per line average about 30 percent higher than those of the HM.
- Comparisons with the other models also suggest that the current version of the HCPM may understate costs in high-density areas and overstate costs for low-density areas. More specifically:
  - For Colorado wire centers above 1,000 lines per square mile, the HCPM produces investment costs about 4 percent below the BCPM and about 10 percent above the HM.
  - For the less dense wire centers (below 1,000 lines per square mile), the HCPM estimates are about 35 percent higher than the <u>capped</u> BCPM results and about 40 percent above the HM investment costs.
- The authors of the model have recognized one possible reason for the high costs in low-density areas. The problem relates to how the model assigns CBs to serving areas and wire centers in less densely populated areas. Although they are working to correct this problem in a subsequent version of their model, other potential sources of overestimation in high cost areas also require attention. More specifically, the HCPM does not include wireless technology, which could have a relatively greater cost-reducing effect on low-density areas; thus, it may produce excessive costs for such areas. Thus, basing interstate transfers on the HCPM could result in excessive subsidies for high cost areas.
- This exclusion also underlines the problems with attempting to develop "least-cost" proxy models without area specific data and planning assumptions. Such models can only be least cost if they reflect the options feasible in the real world. As noted above, if a cost minimization exercise fails to include the appropriate constraints, it could also understate costs.
- The estimated investments for loop components—feeder and distribution—differ substantially among the models. The average loop lengths and lengths of the individual loop components also vary from model to model. These deviations raise questions about

the accuracy of the models, especially for estimating costs for smaller areas and less dense wire centers.

- I should note the HCPM is a work in progress and, as the FCC staff continues to work on their model, the results may change. Further, in the limited time available to assess the HCPM, it was extremely difficult to separate the differences in the results attributable to differences in the algorithms from those attributable to differences in assumptions. Thus, we need to examine the more refined version of the model and a more refined version of the documentation for the model in order to test it more fully.

III. Contributions of the HCPM

The HCPM is part of an ongoing effort to generate improvements over the existing proxy models. The, as yet uncompleted, efforts include the following:

- The effort to produce a model that minimizes costs explicitly may be considered an improvement over the existing proxy models. Thus, it seems to improve upon the HM because it tries to design distribution areas around the maximum number of lines that can be served by an SAI rather than by using predefined areas (e.g., CBGs) as serving areas. (The latest version of the BCPM apparently attempts to optimize the design of feeder and distribution plant based on road data, with the assumption that population clusters are located near roads.)

  - The CENBLOCK module creates "distribution areas," *i.e.* areas that are served by the same subfeeder (and in this version of the model, the same SAI), rather than using predefined geographic regions. That is, CENBLOCK aggregates CBs into distribution areas, using rules that can ensure that distribution areas are no greater than about 2000 lines (HCPM Documentation, at 4). BCPM now takes a similar approach to the HCPM in this regard. (Unfortunately, however, the "distribution areas" produced by these models do not reflect realistic optimization approaches or actual company-specific data and experience.)

  - A second refinement effort of the model is its use of "optimization" routines for building plant. For instance, the number of subfeeders to be constructed is based on an optimization routine that is supposed to determine the least cost number of subfeeders. (HCPM Documentation, at 12) The use of these routines may be superior to the engineering rules of thumb used by the other models. (However, as discussed below, the inherent limitations of such models suggests that the effort may not produce realistic results; even the HCPM's optimization routines ignore real-world constraints.) Note also that use of optimization programs may be less desirable than use of engineering guidelines developed by actual local telephone companies based on real world planning practices and engineering studies.

- Use of Pascal allows greater computational efficiency than spreadsheet models, and thus, facilitates the types of cost minimization algorithms that the HCPM introduces. Pascal code is also more explicit than spreadsheet formulae that may be spread out over numerous cells; thus, the algorithms are easier to check than those in the spreadsheets. On the other hand, the HCPM's use of Pascal code may make it somewhat less accessible than spreadsheets that are in more general use.
- The HCPM (like the BCPM) takes account of terrain slope, and the HM does not appear to do so.
- The use of CB data in its location algorithms should provide more precise plant placement results and line counts than earlier algorithms. (But, see the discussion below regarding the proxy models' inherent inaccuracy for developing line estimates and, thus, costs for areas below the wire center level.)

IV. LIMITATIONS OF THE HCPM

A. The HCPM, like other proxy models, oversimplifies the cost minimization problem faced by the ILECs.

Although the HCPM uses optimization algorithms, it does not really choose loop characteristics based on all of the factors faced by telecommunications firms.

- Firms cannot really optimize the network on a once for and for all basis; they must account for growth and maintenance expenses, not just investment. ILECs must minimize the sum of expected investment <u>and</u> expenses <u>over time</u>. The HCPM, like the other proxy models, does not do so. The FCC's July 1997 FNPRM recognized this problem with the other proxy models when it noted that neither the BCPM nor the Hatfield model "seeks to minimize the total lifetime cost, including <u>maintenance</u>, of outside structure plant mix."[3] Unfortunately, the current version of the HCPM does not solve this problem. It does not account for expenses or growth in its algorithms.
- Combining the HCPM modules (either in their current form or with the refinements under development by the FCC staff) with either the HM or the BCPM would not overcome this limitation. To do so, the minimization process would have to consider and minimize the net present value of expected lifetime investment, growth and maintenance costs in an integrated fashion. Replacing the HM or BCPM loop investment calculations with the

[3] FCC Further Notice of Proposed Rulemaking, FCC 97-256 CC Docket No. 96-45 and CC Docket No. 97-160, Released July 18, 1997, para. 56 (emphasis added).

HCPM's loop investment modules would leave expenses to a separate phase of the calculation and would certainly not include growth because the other models do not calculate growth costs in the outside plant modules.

- Furthermore, firms can not simply minimize the costs of providing a single service in isolation.
  - They must take account of demand for other services as well as cost minimization. (The FCC Universal Service Order recognized this implicitly when it stated that design should not inhibit advanced forward-looking services.[4])
  - And, to the extent that firms limit optimization to minimizing costs, they would need to minimize all costs, i.e., switching costs and transport costs as well as loop costs. Thus, minimizing loop costs without regard to these components will not truly minimize costs.

As noted above, it may not be possible to construct a proxy model that would properly include all of the factors that real firms take into account in optimizing the network.

B. Like the other proxy models, the HCPM does not minimize costs subject to the same real world constraints faced by either ILECs or CLECs.

Because it is a proxy model, the HCPM does not produce costs that <u>any real</u> firm will face. It cannot produce costs that either an ILEC or a CLEC will face.

- It does not recognize that real world ILEC engineers must start from existing plant design and add to it incrementally. They can not simply redesign serving areas as if there were no network in the first place.
- It does not produce estimates for CLECs either. In concept, a new entrant can build plant on a blank slate. However, the HCPM would likely understate an entrant's costs as well because it assumes that a single firm serves the entire market at one time, thereby achieving economies of scale that are unattainable in a multi-provider market.

These are fundamental flaws of the FCC's basic concept that characterize all of the proxy models advanced as providing forward looking TSLRIC or TELRIC. As a result, any

---

[4] "The loop design incorporated into a forward-looking economic cost study or model should not impede the provision of advanced services." See para. 250(1) of the Universal Service Order, FCC-97-157, Released May 8, 1997.

such model, including the HCPM, will not be able to produce costs that are appropriate for pricing purposes. If the purpose is to simply approximate differences in costs across areas or states using a single model for consistency, this would be less of a problem; however, if the purpose is to replicate the costs that a carrier incurs to provide a service, then models with such intrinsic downward biases will fail to achieve this purpose.

C. The detailed algorithms are still overly simple.

The HCPM uses an unrealistically simple distribution plant approach. The rules for creating a "distribution area" are also overly simple—as might be expected by any process that is intended to simulate what amounts to a full time job for numerous engineers with years of experience.

- The HCPM's placement of outside plant does not take into account many of the constraints such as road layout, natural barriers, political restrictions on support structure, highways, and other real obstacles. It also lays out everything in a grid and uses 90 degree angles. This may be one of the reasons that the HCPM's distribution plant investment estimates are higher than those of the other models. The HM (4.0) continues with this approach, while the BCPM has modified it somewhat by using diagonals in part of its distribution plant algorithms; thus, other factors must also be at work. (See results summarized below.)

- The "FEEDDIST" module seems to be quite similar to the HM and earlier versions of the BCPM. The overall design of the plant is almost identical to their hypothetical methodologies, e.g., using four feeders branching out from the wire center, division of areas into quadrants, building out subfeeders orthogonal to the feeders. The calculation of investment from the loop plant design uses similar approaches to cable costs, type of plant by density, and structure costs by density to take the loop design and create an investment number.

- The HCPM assumes uniform distribution of households within an area (i.e., CB), although CBs are much smaller than the CBGs used in earlier versions of the other models. Thus, the problems associated with this approach may be less severe than they were in previous models. Nevertheless, this could bias the cost results upward for less dense areas. Indeed, as discussed below, the HCPM's initial estimates appear to be much higher than the costs estimated from the other models for low density areas.

- The HCPM's mix of aerial, buried, and underground structure depends only on the density of the area in which these structures are to be built and not on the actual area characteristics (e.g., terrain type, topography, location of the major roads, zoning restrictions and natural barriers). The HCPM does not address FCC criticisms of the other proxy models that were contained in the July FNPRM: "Although both the Hatfield and the BCPM include terrain factors and line density zones to estimate costs of installing cable, neither model incorporates terrain factors to make decisions about outside structure plant mix."[5] Even if the model took account of terrain factors, it would not be sufficient to account for the other constraints on plant type. The use of CBs may ease one part of this problem because CB boundaries are determined by roads and natural barriers. However, it would not adequately address the effects of other factors.

D. The HCPM ignores wireless technologies that could reduce costs for low-density areas.

The HCPM does not include wireless technologies, which could bring down the costs of serving less dense areas. This could bias the results upward and lead to an unnecessarily large fund. The July NPRM noted that some commenters "argue that failure to incorporate wireless technology into the models artificially inflates cost estimates, thus leading to unnecessarily high assessments for contributing carriers…." And, the FCC said that "We agree … that, to the extent practical, the selected mechanisms should estimate the cost of providing supported services using wireless technology in areas where wireless technology is likely to be the least-cost, most efficient technology."[6]

E. The HCPM cannot yet be adequately tested.

We cannot fully test the cost minimizing properties of the model because critical parts are missing, e.g., in this release, the model places only one SAI location per grid, but in a "subsequent release… the model will consider additional configurations of 2, 3, and 4 SAI locations within each grid, and will select the configuration that minimizes total feeder plus distribution cost" (HCPM Documentation, at 10). Also, as noted above, the FCC staff intends to compute the copper/fiber cross over point within the model rather than treat it as an input.

---

[5] FCC Further Notice of Proposed Rulemaking, FCC 97-256 CC Docket No. 96-45 and CC Docket No. 97-160, Released July 18, 1997, para. 56.

[6] Ibid., Para. 97 and Para. 99

V. Comparative Analysis of HCPM Results

In this section, I summarize our analysis of the HCPM model results. I focus on several primary cost drivers to assess the models at the wire center level: line counts (and mix, e.g., residence v. business), density (lines per square mile) average loop length, and plant investment mix (i.e., the mix of feeder, distribution, and drop investment). These results are preliminary because the HCPM and the other models remain in a state of flux and because the HCPM has only been available for limited analysis and testing for several weeks. Assessing the HCPM at this time is particularly difficult because data are only available for one state and a small number of other wire centers; and, the appropriate benchmark against which to test a model, i.e., actual forward looking cost estimates taking account of company-specific inputs and planning assumptions are not available to me. (Since USWest serves Colorado and sponsors the BCPM, it could be argued that the BCPM would provide a reasonable basis of comparison; however, the BCPM results are not based on Company specific inputs. This is indicated by the fact that the line counts in the BCPM for a large sample of USWest Colorado wire centers differ substantially from the USWest data reported to the FCC.)

A. Wire center line-count comparisons show that the proxy models do not accurately estimate the number of lines served.

Differences in the number of lines could affect cost per line by changing the degree to which fixed structure costs are shared. The proxy model wire center line counts differ substantially from each other and from USWest's actual data;[7] thus, the algorithms used to assign lines to wire centers are inaccurate, and wire center costs are also inaccurate. Results for smaller areas such as CBGs and CBs would be even less precise. It would be possible, in principle, to obtain accurate wire center counts from the ILECs. (USWest provided publicly available wire center level line counts, but other ILECs treat these data as proprietary.) However, even if the FCC were successful in obtaining these data: (1) this would not solve the

[7] USWest numbers are calculated from data request response, "USWC:ATT1," filed with the FCC.

problem at the less aggregate levels; and (2) wire center level cost estimates could be inaccurate because the number and mix of lines assigned to areas within a wire center affect wire center cost estimates. For example, if the model places too many lines close to the switch location, it could understate costs.

To examine how accurately the models assign lines to wire centers (and to allow an analysis of the effect of density on the cost estimates), we selected a large sample of wire centers for Colorado stratified by density. The sample includes 35 wire centers that serve over 1 million USWest lines and account for approximately 45 percent of the USWest total for Colorado.[8] Our analysis of these data shows that:

- The average percentage point difference between the HCPM estimates of total lines and the USWest actual wire center figures is about 22 percentage points. (This is the average of the absolute values of the percent differences.) The BCPM produces similar results. The HM estimates also diverge substantially from the actual data.

The patterns of differences from the actual wire center line counts are more or less random for all three. Figure 1 attached below shows the percentage point differences from the actual wire center counts for each of the three models. It reveals that the 22 percentage point average includes:

- Differences from 76 percent below the actual line counts to about 37 percent above for the HCPM, from 62 percent below to 78 percent above for the HM, and from 76 percent below to 25 percent above for the BCPM.
- In many wire centers, the line counts vary substantially from model to model. For example, in DNVRCOCH, the HM shows 78 percent too many lines, the HCPM estimates 6 percent too few and the BCPM has 19 percent too many.

The variations are also extreme when we consider residence and business lines separately. The percentage point deviations from USWest actual data for each model are shown in Figures 2 and 3 attached below.

---

[8] The sample includes the three wire centers with densities above 5,000 lines per square miles, which account for 24 percent of the lines in Colorado, and samples of 4-6 wire centers from the following density groups: 3,000 to 5,000, 1,000 to 3,000, 500 to 1000, 100 to 500, 50 to 100, 25 to 50 and 0 to 25 lines per square mile. The total number of loops, excluding non-working loops, reported to the FCC by USWest (see footnote 8 above) was 2,716,495. Our sample included 1,216,986.

- The average percent differences for residence line counts are 14, 22 and 15 percentage points for the HM, HCPM and BCPM, respectively. The margin of the deviation is as high as from +21 percent to -61 percent in the HM, +40 percent to -59 percent in the HCPM, and from +26 percent to -63 percent in BCPM.
- The average percentage point deviations in the business estimates are 44 percentage points for the HM, 37 percentage points for the HCPM and 33 percentage points for the BCPM. The margin of the deviation is as high as from +151 percent to -70 percent in the HM, +92 percent to -95 percent in the HCPM, and from +77 percent to -82 percent in the BCPM.

The dissaggregate data show even more extreme differences from model to model and from the actual USWest data than the total line counts because the offsetting effect of aggregating the two types of lines (and thus masking the errors in each) is not present. These large deviations indicate that results for areas smaller than wire centers are likely to be unreliable because: (1) the mix of business and residence lines assigned to an area affects the cost per line; (2) actual business line counts are not available for CBs and are more difficult to estimate than residence line counts and (3) inaccuracies in business line counts (as well as residence line counts) are likely to be even larger for individual CBGs or CBs than they are for individual wire centers, for which excessive line estimates for some CBs or CBGs are offset by underestimates for other CBs or CBGs.

As some commenters also recognize, and I agree, more detail makes the models more complex and creates a false sense of precision because the underlying data are not disaggregated at the requisite levels. According to these commenters:

> because many input data, such as line counts, are not available for such small areas, using excessively small geographic units makes the model more complex, requires more powerful computers to calculate universal service support, and creates a false sense of precision because the input data is still not disaggregated at that level.[9]

This lack of precision would result in incorrect universal service support levels and inaccurate pricing signals to new entrants.

[9] FNPRM, FCC 97-256, Para. 39, footnote omitted. (FCC citing AT&T/MCI model comments.)

B. The HCPM may understate forward looking costs in more urban (high-density) areas and overstate costs for low-density areas.

In this section, I examine how the various proxy model investment cost estimates compare with each other and how they vary with changes in wire center density. These results are based on runs of each model for each wire center in the sample described above. The results are preliminary for the reasons discussed above.[10] Nevertheless, given the complexities of the models, it is helpful to compare their results to better understand how the models work and to shed light on the plausibility of the results. The comparisons indicate that:

- The HCPM estimates of investment per line tend to be higher than either the HM or the BCPM results. The HCPM weighted average investment per line is about 30 percent higher than the corresponding figure from the HM. This is consistent with prior findings that the HM has generated relatively low estimates. The HCPM preliminary estimates are also higher than the capped BCPM estimates.
- The current version of the HCPM produces lower costs for high density wire centers and higher costs for low-density areas than the other models. More specifically:
  - For wire centers with more than 1,000 lines per square mile, the weighted average HCPM investment per line costs are about the same those of the BCPM; however they are about 10 percent higher than the HM results.
  - For the less dense wire centers (below 1,000 lines per square mile), the HCPM weighted average investment per line estimates are about 35 percent higher than the <u>capped</u> BCPM results and about 40 percent above the HM investment costs.

The HCPM documentation explains one possible source for the pattern of results: the model currently does not assign isolated CBs within a grid to a neighboring grid even though they could be less expensive to serve from that adjoining grid. (HCPM Documentation at 6.) The modelers expect that this problem will be addressed in the next iteration of the model.[11]

---

[10] They are also preliminary because time constraints and limitations of the available documentation did not permit us to isolate differences attributable to algorithms form those attributable to the input assumptions.

[11] Another shortcoming of the current algorithm is that for the large CBs, significantly larger than the standard grid used, the CENBLOCK module does not break the CB down into smaller areas even though "it might be inappropriate to assign the entire population of the block to the particular grid containing the interior point of the block." (HCPM Documentation, p. 6) The effect of this imprecision on the HCPM cost estimates is not clear. By assigning the customers living outside the grid to the grid, CENBLOCK increases the density of the grid. As density increases, the costs of the user-adjustable inputs, such as structure placement and feeder distribution interface, and the amount of more expensive plant, such as underground and buried, increase as

However, another problem that could result in overstating costs in low densities should also be addressed. This can be seen in Figure 4, which shows the effect of removing the cap on loop costs in the BCPM. Without caps, the BCPM and the HCPM produce much higher costs in low-density areas than the other models. The BCPM's $10,000 per line cap on investment is an effort to recognize that the wireline technologies in the model would be replaced by lower cost wireless systems if wireline loop investment would exceed $10,000 per line.[12] By excluding a technology likely to have a relatively greater cost-reducing effect on low-density areas,[13] the HCPM may produce excessive costs for such areas.

C. Analysis of individual wire center results and of specific investment components shows even more discrepancies among the models.

As with line counts, differences among components of aggregate investment per line can be hidden if we look only at averages within density groups or the average total investment per line without examining the components. Thus, in this section, I present more detailed results.

1. Wire-center results show large variations.

Although the weighted average results for the density groups presented above reveal an apparent tendency of the HCPM to overstate costs in low-density areas, they mask the substantial variations across wire centers. Figures 4 and 5 illustrate these differences. They show that the HCPM produces lower estimates than the other models in some wire centers, but

---

well; therefore, the total loop cost could be overestimated by the HCPM in such cases. However, since the population of the census block is now "squeezed" into a smaller area, the length of the individual lines will decrease; therefore, the investment per line could be underestimated.

[12] FNPRM, FCC 97-256, Para. 96. "In calculating the cost of providing service, BCPM attempts to account for the possibility that wireless technology may be less expensive than wireline technology, while Hatfield does not. To calculate the cost of providing service, BCPM assumes that if the loop investment for serving a single customer exceeds $10,000.00, an efficient carrier would not use wireline service, but would substitute wireless service instead."

[13] The prospects for wireless lowering costs were discussed earlier in this analysis. Another factor that could lead to overstated costs in low-density wire centers—assuming that lines are uniformly distributed throughout CB or a microgrid—was also discussed above.

higher estimates in other wire centers with similar density. The variations suggest that the concept that a given model can produce accurate estimates for numerous small areas may not be achievable in practice.

2. Variation in loop components.

The basic task that the three models seek to accomplish is the same—find the least-cost plant design to provide universal service. If they successfully accomplished this task, we might expect that the network designs they would produce would be similar within a given wire center—e.g., the loop lengths and mix of loop components would be similar. They are not.[14]

- Analysis of the estimated investments for loop components—feeder and distribution—reveals substantial deviations among the models. For example, the HCPM investment per line in distribution plant is much larger than that of the other models. In the most dense wire center that we examined the HCPM distribution investment per line is about $103 while the HM and the BCPM are $65 and $69, respectively. At the median density the HCPM invests $378 per line in distribution, while the HM invests $290 and the BCPM invests only $90 per line. In the least dense wire center, the HCPM invests $1,881 dollars in distribution, while the HM invests only $729 and the BCPM invests only $329.[15]
- Loop lengths and lengths of the individual loop components also vary from model to model. Given the pattern of investment costs, it is not surprising that the HCPM loops are almost always longer that those of the BCPM; however, it is surprising that its loop lengths are often shorter than those of the HM. Furthermore, the HCPM distribution loop component is much longer than that of the BCPM; however, its average distribution loop length is <u>shorter</u> than the HM in most wire centers. This is surprising because the HCPM produces so much more distribution investment than the HM. One possible explanation is that the mix of structure is different. Others include differences in line counts and differences in input costs. Time constraints have not allowed us to ascertain why these differences pertain[16];

---

[14] Given the difficulties of extracting such detailed data from these models, we used a smaller sample of wire centers for this task. The sample include 11 of the wire centers from our larger sample and was again selected to allow us to look at results for wire centers with a variety of different densities.

[15] Note that the BCPM model does not clearly distinguish drop investment from distribution; nevertheless, even if we aggregated these two categories and compared distribution plus drop investments from the models, we would find substantial differences.

[16] For example, when we attempted to change the inputs in the HCPM to be equivalent to the apparently analogous HM inputs, we found that the costs in the HCPM <u>increased</u>. This seemed surprising because the HM produces lower costs than the HCPM. However, our experience suggests that, based on the information available, and within the time available, we simply could not change enough of the input values to use fully equivalent inputs. It also suggests that there are differences in the way the models use the same types of inputs, which we could